

CLAIMS

1. A neutral particle beam processing apparatus comprising a plasma discharging space inside which processing gases are converted into plasma ions through a plasma discharge, a heavy metal plate which converts the plasma ions into neutral particles through collisions, a plasma limiter which prevents plasma ions and electrons from passing through and allows the neutral particles produced by collisions of the plasma ions with the heavy metal plate to pass through, and a treating housing inside which a substrate to be treated is located, wherein the plasma discharging space is sandwiched between the heavy metal plate and the plasma limiter.
- 10 2. The neutral particle beam processing apparatus as set forth in claim 1, wherein the plasma limiter has holes or slits that selectively allows the neutral particles to pass through the plasma limiter while interrupting plasma ions and electrons from passing through.
- 15 3. The neutral particle beam processing apparatus as set forth in claim 2, wherein the plasma limiter further comprises a member selected from a magnetic unit to impress magnetic field and an electric unit to impress electric field to the holes or slits.
- 20 4. The neutral particle beam processing apparatus as set forth in claim 1, wherein a heavy metal plate is installed above the plasma discharging space and the plasma limiter is located below the plasma discharging space, and the plasma ions generated in the plasma discharging space are directed to the heavy metal plate to which a bias voltage is applied and collide with the heavy metal plate to produce neutral particles and then the produced neutral particles enter into the plasma limiter.
- 25 5. The neutral particle beam processing apparatus as set forth in claim 1, further comprising a collimator, between the plasma limiter and the treating housing, to collimate the neutral particles which had passed through the plasma limiter.

6. The neutral particle beam processing apparatus as set forth in claim 5, wherein the collimator has holes to collimate the neutral particles.

7. A neutral particle beam processing apparatus, comprising:

5 a) a reaction chamber with an opened lower part, comprising an inner space, an gas inlet port and an gas outlet port installed at a side of the reaction chamber, and a heavy metal plate, wherein the inner space of the reaction chamber is a plasma discharging space and the heavy metal plate is installed above the plasma discharging space, processing gases introduced into the plasma discharging space through the gas inlet port being converted into plasma ions through a
10 plasma discharge and then the plasma ions being converted into neutral particles by collisions with the heavy metal plate;

15 b) a plasma limiter located below the reaction chamber comprising holes or slits to pass the neutral particles through while interrupting the plasma ions and electrons from passing through, wherein the plasma limiter has holes or slits that selectively allows neutral particles to pass through the plasma limiter while interrupting plasma ions and electrons from passing through; and

c) a treating housing located below the plasma limiter inside which a substrate to be treated with the neutral particles is located.

20 8. The neutral particle beam processing apparatus as set forth in claim 7, wherein the plasma limiter further comprises a member selected from a magnetic unit to impress magnetic field and an electric unit to impress electric field to the holes or slits.

25 9. The neutral particle beam processing apparatus as set forth in claim 7, further comprising a collimator, between the plasma limiter and the treating housing, to collimate the neutral particles which had passed through the plasma limiter.

10. The neutral particle beam processing apparatus as set forth in claim 9, wherein the collimator has holes to collimate the neutral particles.

11. The neutral particle beam processing apparatus as set forth in claim 12, wherein a bias 5 voltage is applied to the heavy metal plate to direct the plasma ions to the heavy metal plate.

12. A surface treatment method with neutral particles, which comprises the steps of:

a) arranging a plasma discharging space inside which processing gases are converted into plasma ions through a plasma discharge, between a heavy metal plate which converts the 10 plasma ions into neutral particles through collisions and a plasma limiter which prevents plasma ions and electrons from passing through and allows the neutral particles produced by collisions of the plasma ions with the heavy metal plate to pass through;

b) converting the processing gases into plasma through a plasma discharging in the plasma discharging space;

c) directing the plasma ions generated in the plasma discharging space to the heavy metal plate with aid of a bias voltage applied to the heavy metal plate, thereby producing neutral particles by collisions of the plasma ions with the heavy metal plate;

d) passing the neutral particles reflected by the heavy metal plate via the plasma discharging space through the plasma limiter; and,

20 e) contacting the neutral particles, which had passed through the plasma limiter, with a surface of a substrate to achieve surface treatment of a substrate.

13. The surface treatment method as set forth in Claim 12, wherein the plasma limiter has holes or slits to selectively pass neutral particles through and interrupt plasma ions and electrons 25 from passing through.

14. The surface treatment method as set forth in Claim 13, wherein the plasma limiter further comprises a member selected from a magnetic unit to impress magnetic field and an

electric unit to impress electric field to the holes or slits.

15. The surface treatment method as set forth in Claim 12, further comprising, between d) step and e) step, passing the neutral particles which had passed through the plasma limiter 5 through a collimator with holes to collimate the neutral particles.